SYLLABUS OF
UNDERGRADUATE DEGREE COURSE

Mechanical Engineering

Effective for the students admitted in year 2021-22 and onwards.

B.Tech. : Mechanical Engineering
3rd Year - V Semester

SN	Category	Course code	Course Title	Hours			Marks			Credit
				L	T	P	IA	ETE	Total	
THEORY										
1	DC	5ME4-01	Theory of Machines-II	3	1	0	30	70	**100**	**4**
2		5ME4-02	Heat Transfer	3	1	0	30	70	**100**	**4**
3		5ME4-03	Machine Design-I	3	0	0	30	70	**100**	**3**
4		5ME4-04	Manufacturing Technology- II	3	0	0	30	70	**100**	**3**
5	DE	**DE-I**		2	0	0	30	70	**100**	**2**
		5ME5-11	Automobile Engineering							
		5ME5-12	Fuels and Combustions							
		5ME5-13	Additive manufacturing							
		5ME5-14	Mechatronics							
		5ME5-15	Computer Integrated Manufacturing Systems							
6	DE	**DE-II**		2	0	0	30	70	**100**	**2**
		5ME5-16	Entrepreneurship Development							
		5ME5-17	Surface Engineering							
		5ME5-18	Lean Manufacturing							
		5ME5-19	Introduction to Total Quality Management and reliability							
		5ME5-20	Composite Materials							
			Sub Total	**16**	**2**	**0**	**180**	**420**	**600**	**18**
PRACTICAL & SESSIONAL										
7	DC	5ME4-20	Manufacturing Technology Lab	0	0	2	60	40	**100**	**1**
8		5ME4-21	Theory of Machines Lab- II	0	0	2	60	40	**100**	**1**
9		5ME4-22	Heat Transfer Lab	0	0	2	60	40	**100**	**1**
10		5ME4-23	Machine Design Practice-I	0	0	2	60	40	**100**	**1**
11	UI	5ME7-30	Industrial Training	0	0	2*	60	40	**100**	**3**
12	CCA	5ME8-00	SODECA/NCC/NSS/ ANANDAM/IPR	-	-	-	-	100	**100**	**1**
			Sub- Total	**0**	**0**	**10**	**300**	**300**	**600**	**8**
			TOTAL OF V SEMESTER	**16**	**2**	**10**	**480**	**720**	**1200**	**26**

L = Lecture, **T** = Tutorial, **P** = Practical, **IA**=Internal Assessment, **ETE**=End Term Exam, **Cr**=Credits
***for calculation of contact hours**

B.Tech. : Mechanical Engineering
3rd Year - VI Semester

S.N.	Category	Course Code	Course Title	Hours			Marks			Credit
				L	T	P	IA	ETE	Total	
THEORY										
1	DC	6ME4-01	Turbo Machines	3	1	0	30	70	**100**	**4**
2		6ME4-02	Control System & Advanced Measurement Theory	3	1	0	30	70	**100**	**4**
3		6ME4-03	Machine Design-II	3	0	0	30	70	**100**	**3**
4		6ME4-04	Refrigeration and Air Conditioning	3	0	0	30	70	**100**	**3**
5	DE		**DE-III (Any one)**	2	0	0	30	70	**100**	**2**
		6ME5-11	Non-Destructive Testing							
		6ME5-12	Power Generation							
		6ME5-13	Robotics and Automation							
		6ME5-14	Principles of Management							
		6ME5-15	Alternative Fuels							
		6ME5-16	Operation Management							
			Sub Total	**14**	**2**	**0**	**150**	**350**	**500**	**16**
PRACTICAL & SESSIONAL										
6	DC	6ME4-20	Machine Design Practice-II	0	0	2	60	40	**100**	**1**
7		6ME4-21	Turbo Machine Lab	0	0	2	60	40	**100**	**1**
8		6ME4-22	Thermal Engineering Lab	0	0	2	60	40	**100**	**1**
9		6ME4-23	Automation Lab	0	0	2	60	40	**100**	**1**
10	UI	6ME7-50	Mini Project			4*	60	40	**100**	**2**
11	CCA	6ME8-00	SODECA/NCC/NSS/ ANANDAM/IPR	-	-	-	-	100	**100**	**2**
			SUB TOTAL	**0**	**0**	**12**	**300**	**300**	**600**	**8**
			TOTAL OF VI SEMESTER	**14**	**2**	**12**	**450**	**650**	**1100**	**24**

L = Lecture, **T** = Tutorial, **P** = Practical, **IA**=Internal Assessment, **ETE**=End Term Exam, **Cr**=Credits

***for calculation of contact hours**

5ME4-01: Theory of Machines-II

Credit: 4Max **Marks: 100(IA: 30, ETE: 70)**

3L+1T+0P **End Term Exam: 3 Hours**

Course Objectives

1. CO-1: It provides the knowledge to select static or dynamic force analyses to analyse the systems.
2. CO-2: It gives the ideas and fundamentals of Gyroscope and method of balancing with engineering applications
3. CO-3: It gives the ideas and fundamentals of vibrations, classification, and essential terminology.
4. CO-4: It gives the idea of single degree of freedom and two degrees of freedom systems and its vibration analyses by using different methods, vibration isolation, vibration absorbers and transmissibility and critical speed of shafts, which helps engineer to select proper parameters to avoid excessive vibrations.
5. CO-5: It gives the idea of multi degree of freedom systems and its vibration analyses by using different methods, It also shares the knowledge continuous system and its vibration analyses.

Course Outcomes

Upon successful completion of the course the students will be able to;

1. Have the knowledge to select static or dynamic force analyses to analyse the systems.
2. Have the ideas and fundamentals of Gyroscope and method of balancing with engineering applications
3. Give the ideas and fundamentals of vibrations, classification, and essential terminology.
4. Give the idea of single degree of freedom and two degrees of freedom systems and its vibration analyses
5. Give the idea of multi degree of freedom systems and its vibration analyses by using different methods.

Sr. No.	Contents	Hours
1.	**Static and Dynamic Force Analysis**: Definition, Constraint and applied forces, Static Equilibrium, Equilibrium of two-force and three-force members, Equilibrium of four-force members, Free-body diagrams, Principle of virtual work, Friction in mechanisms, D'Alembert's principle, Simple and compound pendulum, Punching presses.	3
2.	**Gyroscope**: Principles of gyroscopic couple, effect of gyroscopic couple and centrifugal force on vehicles taking a turn, stabilization of ship.	4
	Balancing: Balancing of rotating masses in same and different planes, balancing of reciprocating masses, swaying couple, hammer blow and tractive effort.	7
3.	**Gears**: Introduction, Classification of gears, Law of gearing, Velocity of Sliding, Tooth forms and their comparisons, Cycloidal and Involute Profile Teeth & comparison, Systems of gear teeth, Length of path of contact, Arc of contact, Contact ratio, Minimum number of teeth on gear and pinion to avoid interference, Undercutting, Velocity Ratio and Centre Distance of Helical Gears, Helical Gear Forces and Efficiency, Velocity Ratio and Centre Distance of Worm Gears, Efficiency of Worm Gears	9
	Gear trains: Simple, compound, reverted and planetary gear trains, sun and planet gear train.	4

4.	**Vibration**: Importance and scope of vibrations, terminology and classification, Concept of Degrees of freedom, Harmonic motion, vectorial representation, complex number representation, addition. Introduction to Vibration: Importance and scope of vibrations, terminology and classification, Concept of Degrees of freedom, Harmonic motion, vectorial representation, complex number representation, addition.	3
5.	**Vibrations of single degree of freedom systems**; Free and forced vibrations, Longitudinal transverse and torsional vibrations of one dimensional damped and undamped systems using Newton's second law, D' Alembert's principle and Principle of conservation of energy, Types of damped vibrations, Vibration Isolation and Transmissibility, Force transmissibility, Motion transmissibility, Forced vibration with rotating and reciprocating unbalance, Materials used in vibration isolation. Critical speed of light shaft without damping.	8
6.	**Vibrations of Two Degrees of Freedom:** Principle mode of vibration, Mode shapes, Undamped forced vibrations of two degrees of freedom system with harmonic excitation, Vibration Absorber, Undamped dynamic vibration absorber and centrifugal pendulum absorber	5
	Total	43

TEXT BOOKS

1. Rattan S. S., Theory of Machines, Tata McGraw Hill, 2017,4th Ed
2. Bevan T., Theory of Machines, CBS Publishers and Distributors, 3rd Ed., 2005.

REFERENCE BOOKS

1. Rao J S, Dukkipati R. V., Mechanism and Machine Theory, New Age International, 2006, 2nd Ed.
2. Uicker J J Jr, Pennock G R, Shigley J E, Theory of machines and mechanisms, Cambridge University Press, 6th Ed.
3. Meirovitch L., Elements of Vibration Analysis, McGraw Hill, 2014, 2nd Ed.
4. Thomsom W. T., M.D. Dahleh, Padmanabhan C., Theory of Vibration with Applications, Pearson Education, 5th Ed.,

5ME4-02: Heat Transfer

Credit: 4 Max **Marks: 100 (IA: 30, ETE: 70)**

3L+1T+0P **End Term Exam: 3 Hours**

Course Objective:

The course should enable the students to:

1. Understand the concepts and different modes of heat transfer.
2. Analyze the different systems using the concepts of conduction, convection and radiation.
3. Understand the basic concepts of design of heat exchangers.

Course Outcomes:

Student will be able to

1. Understand different modes of heat transfer and apply related heat transfer laws.
2. Calculate the heat flow rate in different engineering applications and its implications on temperature.
3. Design fins and heat exchangers for industrial applications.

Examination note: Please note that data hand book will not be provided to the students in examinations so provide the suitable data in question paper.

S. No.	Contents	Hours
1	Objective, scope and outcome of the course.	1
2	**Introduction:** Heat transfer processes, conduction and radiation. Fourier's law of heat conduction, thermal conductivity, thermal conductivity of solids, liquids and gases, effect of temperature on thermal conductivity. Newton's law of cooling, definition of overall heat transfer coefficient. General parameters influence the value of heat transfer coefficient. **Conduction:** General 3-Dimensoinal conduction equation in Cartesian, cylindrical and spherical coordinates; different kinds of boundary conditions; nature of differential equations; one dimensional heat conduction with and without heat generation; electrical analogy; heat conduction through composite walls; critical thickness of insulation	6
3	**Heat transfer from extended surfaces:** Governing differential equation of fin, fin efficiency and effectiveness for different boundary conditions. Unsteady state heat conduction for slab, cylinder and sphere, Heisler chart.	6
4	**Convective Heat Transfer:** Classification of systems based on causation of flow, condition of flow, configuration of flow and medium of flow – Dimensional analysis as a tool for experimental investigation: Buckingham pi Theorem and Rayleigh's method, application for developing semi – empirical non- dimensional correlation for convection heat transfer – Significance of non-dimensional numbers – Concepts of Continuity, Momentum and Energy Equations – Integral Method as approximate method. **Forced convection:** External Flows: Concepts about hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer -Flat plates and Cylinders. Internal Flows: Concepts about Hydrodynamic and Thermal Entry Lengths – Division of internal flow based on this –Use of empirical relations for horizontal plate and tube flow. **Free Convection:** Development of Hydrodynamic and thermal boundary layer along a vertical plate – Use of empirical relations for Vertical plates and pipes.	10

	Heat transfer with change of phase: Nature of vaporization phenomena; different regimes of boiling heat transfer; correlations for saturated liquid vaporization; condensation on flat plates; correlation of experimental results, drop wise condensation.	
5	**Heat exchangers:** Types of heat exchangers, arithmetic and logarithmic mean temperature differences, heat transfer coefficient for parallel, counter and cross flow type heat exchanger; effectiveness of heat exchanger, N.T.U. method, fouling factor, constructional and manufacturing aspects of heat exchangers.	9
6	**Thermal Radiation:** Plank distribution law, Kirchhoff's law; radiation properties, diffuse radiations; Lambert's law. Radiation intensity, heat exchange between two black bodies heat exchanger between gray bodies. Shape factor; electrical analogy; reradiating surfaces heat transfer in presence of reradiating surfaces.	9
	Total	41

TEXT BOOKS

1. Holman J. P, Heat Transfer, Tata McGraw Hill, New Delhi, (SIE) 10th Ed.
2. Nag P. K., Heat and Mass Transfer, Tata McGraw Hill, (SIE) 3rd Ed.

REFERENCE BOOKS

1. Cengel Y.A., Heat and Mass transfer, Tata McGraw Hill, (SIE) 5th Ed.
2. Ozisik M. Necati, Heat Transfer - A Basic Approach, McGraw Hill, New York, 1985.
3. Frank P. Incropera and David P. DeWitt, Fundamentals of Heat and Mass Transfer, John Wiley & Sons, New York, 2013, 7th Ed., Wiley Student Editiom.

5ME4-03: Machine Design – I

Credit: 3 Max **Marks: 100 (IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objective:

1. To teach students how to apply the concepts of stress analysis, theories of failure and material science to analyse commonly used machine components.
2. To impart knowledge and enable students to design common mechanical components

Course Outcomes:

Student will be able to

1. CO1: Identify considerations for design and selection of materials, factor of safety and standard sizes as per relevant codes/standards for machine components.
2. CO2: Demonstrate understanding of various theories for design under static loading, identify the failure criteria and apply appropriate theory of failure for design.
3. CO3 Analyse stresses in components subjected to direct stresses such as cotter joint, knuckle joint, levers and laminated springs.
4. CO4: Identify failure mechanism and design threaded fasteners, power screw and curved beams,
5. CO5: Understand mode of failure in shafts, keys and couplings and design them for the given specifications.

Examination Note : Students can practice using the data handbook in class, but the data handbook will not be given in the exam, students should memorize the formulas on their own.

S.No.	Contents	Hours
1.	**Introduction:** Scope and outcome of the course, steps in design, requirements of a designer **Materials:** Mechanical Properties and IS coding of various engineering materials, Selection of material from properties and economic aspects. **Manufacturing Considerations in Design:** Standardization, Interchangeability, limits, fits and tolerances, Design consideration for cast, forged and machined parts. Design for assembly.	8
2.	**Design for Strength:** Modes of failure, Strength and Stiffness considerations, Allowable stresses, factor of safety, Stress concentration: cause and mitigation, introduction to fatigue failure	8
3.	**Design of Members subjected to direct stress:** Design of spigot and socket cotter joint and simple knuckle joint **Design of Members in Bending:** Beams, levers and laminated springs. **Failure theories:** Introduction and application for various loading conditions	8
4.	**Design of Members in Torsion** **Shafts:** Design of shafts for strength and rigidity. Solid and hollow shafts. Shafts under combined loading. **Keys:** Type of keys, design of sunk keys **Couplings:** Design of muff coupling, flange coupling and pin type flexible coupling	8

5.	**Design of threaded fasteners:** Bolts of uniform strength, preloading of bolts, Effect of initial tension and applied loads, design of bolted joints subjected to eccentric loading, design of power screws and lead screw **Design of Curved beams:** Design of members which are curved like crane hook, body of C-clamp, machine frame etc.	8

TEXT BOOKS

1. V. B. Bhandari, Design of Machine Elements, McGraw Hill, 5th edition, 2020.
2. R.C. Bahl and V. K. Goel, Mechanical Machine Design, Standard Publishers Distributors, 2010 edition
3. P. C. Sharma and D. K. Aggarwal, Machine Design, S. K. Kataria and Sons (New Delhi), 13th ed., 2017.

REFERENCE BOOKS

1. Richard G. Budynas, J. Keith Nisbett, et al.: Shigley's Mechanical Engineering Design, McGraw Hill Education (India), 11th edition, 2020.
2. U. C. Jindal: Machine Design, Pearson Education India, 1st edition 2010

5ME4-04: Manufacturing Technology- II

Credit: 3 Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To understand the basic concepts of metal forming tool design and presses.
2. To teach students the fundamentals of work holding devices, design tools, dies, jigs and fixtures.
3. To gain knowledge about automatic machine tools and their mechanisms.
4. To learn about the NC, CNC machines, construction details and programming.
5. To provide in depth knowledge in selection of advanced machining process to fabricate intricate and complex shapes in difficult to machine material.
6. To enable the students understand the principles of quality management and quality control.

Course Outcomes

Student will be able to

1. Calculate the required specifications of a press for required operations.
2. Design tools, dies and fixtures for required operations.
3. Develop programs related to manufacturing using codes and analyze the importance of networking in manufacturing environment.
4. Identify and suggest the suitable manufacturing process for advanced materials and critical finishing.
5. Control the manufacturing process during quality planning.

S. No	Contents	Hours
1	**Metal Forming:** Forging and Press tools, Punch-Die for bulk deformation and sheet metal working, Compound, Combination and Progressive dies.	4
2	**Jigs and Fixtures:** Principles of design of Jigs and fixtures and uses, 3-2-1 principle of location and clamping, classification of Jigs & Fixtures, types of clamping and work holding devices, typical examples of jigs and fixtures (Drilling jigs and Milling fixtures), Indexing jigs and fixtures, Automated jigs and fixtures	8
3	**Automats and Semi-automats:** Automatic lathes, capstan and turret lathe machines, swiss automatic, operational planning and turret tool layout, sequence of operations, tracer attachment in machine tools, mechanical-copying machines, Hydraulic tracing Devices, Electric tracing systems, Automatic tracing.	6
4	**Numerical Control (NC) machine tools:** Automation strategies, NC Machine tools, Open and Closed loop, CNC machine tools, DNC machine tools, constructional details, special features, Adaptive control machining center, part programming fundamentals CNC – manual part programming.	6
5	**Modern Machining Methods:** Classification; Abrasive and Water jet; Ultrasonic; Electrochemical; Chemical machining; Electro Chemical Grinding; Electric discharge machining; Plasma arc machining,	6
6	**Statistical Quality Control:** Meaning of Quality and Quality Control, Quality of Design, Quality of Conformance and Quality of Performance, Functions of Quality Control, Implementation of quality at Policy, Design, Manufacturing and Installation stages; Assignable and unassignable causes of	12

	variability in quality. Control charts for Variables and Attributes, Acceptance sampling; OC curve, Single and multiple sampling plans; Total quality management; ISO 9000.	

TEXT BOOKS

1. P. C. Sharma, A Text book of Production Engineering, S. Chand & Company Ltd., 11th Ed.
2. SK Hajra Choudhury, Elements of Workshop Technology Volume 2, Media Promotors and Publishers Pvt. Ltd, 15th Ed.

REFERENCE BOOKS

1. S. Kalpakjian and Schmid, Manufacturing Engineering and Technology, Prentice Hall of India, 7th Ed.
2. A. Ghosh & A. Mallik – 'Manufacturing Science'- East- West Press Private Limited, 2nd Ed.
3. Dale H. Besterfield, Total Quality Management, Pearson, 5th Ed.
4. Jain V.K., Advanced Machining Processes, Allied Publishers, 2007.
5. P. H Joshi, Jigs and Fixtures, Tata McGraw Hill, 3rd Ed.
6. N Mehta, Machine Tools Design and Numerical Control, Tata McGraw Hill, 3rd Ed.

5ME5-11: Automobile Engineering

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To Gain a comprehensive understanding of various automotive systems, including clutches, brakes, gear boxes, steering systems transmission, suspension, braking, and electrical systems.
2. To Develop the ability to analyze and evaluate the design, construction, and performance of individual vehicle components, such as clutches, brakes, gear boxes, steering systems, transmissions, and chassis systems.
3. To Explore emerging trends and advanced technologies in the automotive industry, including electric and hybrid vehicles, autonomous driving, and connected systems.

Course Outcomes

Student will be able to

1. Get a comprehensive understanding of various automotive systems, including clutches, brakes, gear boxes, steering systems transmission, suspension, braking, and electrical systems.
2. Develop the ability to analyze and evaluate the design, construction, and performance of individual vehicle components, such as clutches, brakes, gear boxes, steering systems, transmissions, and chassis systems.
3. Understand the emerging trends and advanced technologies in the automotive industry, including electric and hybrid vehicles, autonomous driving, and connected systems.

S. No	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	2
2	Frame & Body: Layout of chassis, types of chassis frames and bodies, their constructional features and materials. Clutches: single plate, multi-plate, cone clutch, semi centrifugal, electromagnetic, vacuum and hydraulic clutches. Fluid coupling. Brakes: Classification and function; Mechanical, hydraulic, vacuum air and self-engineering brakes; Brake shoes and lining materials.	5
3	Gear Boxes: Sliding mesh, constant mesh, synchromesh and epicyclic gear boxes, Automatic transmission system; Hydraulic torque converter; Drives: Overdrive, Propeller shaft, Universal joints, Differential; Rear axle drives. Hotchkiss and torque tube drives; Rear axle types; Front wheel and All wheel drive.	5
4	Steering system: steering gear boxes, Steering linkages, Steering mechanism, Under and Over steering. Steering Geometry, Effect of camber, caster, king pin inclination, toe in and toe out; Power steering; Integral and linkage types. Suspension system: objective and requirements, Suspension spring, front and rear suspension systems, Independent suspension system Shock absorbers.	5
5	Automotive Electrical System: Battery construction, Charging and testing, battery types, Starting and Battery Charging System: Starter motor construction, types of drive, Alternator construction, regulation and rectification. Ignition System: Magneto and coil ignition systems, System components and requirements, Automotive lighting: Wiring systems Electrical instruments; head lamp, electric horn, fuel level	4

	indicator.	
6	Electric Vehicles: Basic concept of EV, Types of EVs, Hybrid Architecture - Series, Parallel and Series Parallel Configuration, Electric propulsion systems. Energy Storage Technology: Battery Basics, Lead Acid Battery, Different Types of Batteries, Battery Parameters.	4
7	Business: E-mobility business, Electrification challenges, Connected mobility, Autonomous mobility, Case study, E-mobility, Indian roadmap perspective. Policy: EVs in infrastructure system, Integration of EVs in smart grid, social dimensions of EVs. Future of EVs.	3

TEXT BOOKS

1. Singh, Kirpal "Automobile Engineering"; Standard Publishers and Distributors, New Delhi, 13th edition
2. Narang, GBS; "Automobile Engineering"; Khanna Publishers, New Delhi; 20th reprint, 2015
3. Iqbal Husain, Electric and Hybrid Vehicles, CRC Press, ISBN13- 978-1439811757, 2nd edition.

REFERENCE BOOKS

1. Giri, NK; "Automobile Mechanics"; Khanna Publishers, New Delhi; 8th Edition
2. Duffy, JE; "Modern Automotive Technology"; Goodheart-Willcox Company, Incorporated, 2017; 9th edition
3. Ed. by- Muneer T, Kohle ML, Doyle, "A Electric Vehicles: Prospects and Challenges", Elsevier, 2017.

5ME5-12: Fuels and Combustions

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To impart basic knowledge about solid, liquid and gaseous fuels, their origin, classification, preparation procedure and characterization in terms of physico-chemical properties.
2. To teach the students about Solid fossil fuels coal, Coal mining, cleaning and its combustion processes.
3. To expose the students about Liquid fuel section, mainly petroleum, and to provide knowledge about exploration, evaluation, distillation and secondary processing.
4. To study about different important gaseous fuels.
5. To teach the students about combustion of various fuels, their thermodynamics and various combustion appliances
6. To make them aware about the requisite mathematical calculations with their step-wise solutions.

Course Outcomes

Student will -

1. Have Basic knowledge about solid, liquid and gaseous fuels, their origin, classification, preparation procedure and characterization in terms of physico-chemical properties.
2. Have Knowledge about Solid fossil fuels coal, Coal mining, cleaning and its combustion processes.
3. Be exposed about Liquid fuel section, mainly petroleum, and to provide knowledge about exploration, evaluation, distillation and secondary processing.
4. Able to different important gaseous fuels.
5. Know about combustion of various fuels, their thermodynamics and various combustion appliances
6. Be aware about the requisite mathematical calculations with their step-wise solutions.

S. No	Contents	Hours
1	History of Fuels, History of solid fuel, History of liquid fuels and gaseous fuels, Production, present scenario and consumption, Fundamental definitions, properties and various measurements, Definitions and properties of solid fuels, Definitions and properties of liquid and gaseous fuels, Various measurement techniques	2
2	Coal classification, composition and basis, Coal mining, Coal preparation and washing, Combustion of coal and coke making, Action of heat on different coal samples, Different types of coal combustion techniques, Coal tar distillation, Coal liquefaction, Direct liquefaction, Indirect liquefaction, Coal gasification	7
3	Exploration of crude petroleum, Evaluation of crude, Distillation, Atmospheric distillation, Vacuum distillation, Secondary processing, Cracking, Thermal cracking, Visbreaking, Coking, Catalytic cracking, Reforming of naphtha, Hydrotreatment, dewaxing, deasphalting, Refinery equipments	7
4	Natural gas and LPG, Producer gas, Water gas, Hydrogen, Acetylene, Other fuel gases	6
5	Fundamentals of thermochemistry, Combustion air calculation, Calculation of calorific value of fuels, Adiabatic flame temperature calculation, Mechanism and kinetics of combustion, Flame properties, Combustion burners, Combustion furnaces, Internal combustion engines	6

TEXT BOOKS

1. Sarkar Samir; “Fuels and Combustion”; 3rd. ed; Universities Press.

REFERENCE BOOKS

1. Ed. by Richard A. Dave; “Modern Petroleum Technology, Vol 1, Upstream”; IP, 6th ed., John Wiley & Sons. Ltd.
2. Ed. by Alan G. Lucas; “Modern Petroleum Technology, Vol 2, Downstream”; IP, 6th ed., John Wiley & Sons. Ltd.
3. Irvin Glassman; “Combustion”; 2nd ed., Academic Press.
4. Rao B.K. Bhaskar; “Modern Petroleum Refining Processes”; 4th ed., Oxford & IBH Publishing Co. Pvt. Ltd.
5. Nelson W.L.; “Petroleum Refinery Engineering”; 4th ed. Mc-Graw Hill Book Company.
6. Griswold John; “Fuels Combustion and Furnaces”; Mc-Graw Hill Book Company Inc, 1946

5ME5-13: Additive Manufacturing

Credit: 2 Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To develop a comprehensive understanding of fundamental additive manufacturing – alternatively, "three-dimensional (3D) printing"
2. To provide comprehensive knowledge of the wide range of additive manufacturing processes, capabilities and materials
3. To understand the software tools and techniques used for additive manufacturing.
4. To create physical objects that facilitates product development/prototyping requirements.
5. To familiarize students how commercial rapid prototyping systems use these models to perform activities such as part building, materials used etc.

Course Outcomes

Upon successful completion of the course the students will be able to

1. Demonstrate appropriate level of understanding on principles of additive manufacturing processes.
2. understand the role of additive manufacturing in the design process and the implications for design
3. Choose appropriate materials for additive manufacturing processes
4. Apply suitable CAD tools and CAD interface for additive manufacturing process
5. Develop physical prototypes by identifying suitable process with optimum process parameters.

S. No	Contents	Hours
1	**Overview of Rapid Product Development (RPD):** Need for the compression in product development, history of RP systems, Definition of RPD; Components of RPD. Rapid Prototyping (RP); Principle of RP; Technologies and their classifications.	2
2	**Stereo Lithography Systems**: Principle, Process parameter, Process details, Data preparation, data files and machine details, Application **Selective Laser Sintering & Fusion Deposition Modelling:** Selective Laser Sintering: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications. Fusion Deposition Modelling: Principle, Process parameter, Path generation, Applications.	6
3	Solid Ground Curing: Principle of operation, Machine details, Applications. Laminated Object Manufacturing: Principle of operation, LOM materials. Process details, application.	4
4	**Rapid Tooling (RT):** Introduction to RT, Indirect RT processSilicon rubber molding, Epoxy tooling, Spray metal tooling and Investment Casting, Cast kirksite, 3Q keltool, etc. **Direct RT processes:** Laminated Tooling, Powder Metallurgy based technologies, Welding based technologies, Direct pattern making (Quick Cast, Full Mold Casting),	8
5	**Emerging Trends in RT, Reverse Engineering**: Geometric data acquistion, 3D reconstruction, Applications and Case Studies, Engineering applications, Medical applications.	4
6	**Processing Polyhedral Data:** Polyhedral B-Rep modeling, STL format, Defects and repair of STL files.	4

	Introduction to software for RP : Brief overview of Solid view, magics etc	

TEXT BOOKS

1. Chee Kai Chua, Kah Fai Leong, Chu Sing Lim, Rapid Prototyping: Principles and Applications, World Scientific Press, 3rd Ed.
2. Ali K. Kamrani, Emad Abouel Nasr, Rapid Prototyping: Theory and Practice, Springer, 2006

REFERENCE BOOKS

1. Brent Stucker, David W. Rosen, and Ian Gibson, Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Springer, 2nd Ed., 2015.
2. Noorani R, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons. 1st Ed.

5ME5-14: Mechatronics

Credit: 2 Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. Understand key elements of Mechatronics system, representation into block diagram
2. Understand concept of transfer function, reduction and analysis
3. Understand principles of sensors, its characteristics, interfacing with DAQ microcontroller
4. Understand the concept of PLC system and its ladder programming, and significance of PLC systems in industrial application
5. Understand the system modeling and analysis in time domain and frequency domain.
6. Understand control actions such as Proportional, derivative and integral and study its significance in industrial applications

Course Outcomes

Upon successful completion of the course the students will be able to

1. CO1 - Identification of key elements of mechatronics system and its representation in terms of block diagram
2. CO2 - Understanding the concept of signal processing and use of interfacing systems such as ADC, DAC, digital I/O
3. CO3 - Interfacing of Sensors, Actuators using appropriate DAQ micro-controller
4. CO4 - Time and Frequency domain analysis of system model (for control application)
5. CO5 - Development of PLC ladder programming and implementation of real life system.
6. CO6 – various case studies for practical applications

SN	CONTENTS	Hours
1	Introduction: Objective, scope and outcome of the course. Overview of Mechatronics: Historical perspective, Definition,	1
2	Applications, Block diagram of Mechatronic system, Functions of Mechatronics Systems, Systems Engineering, Verification Vs Validation, Benefits of mechatronics in manufacturing.	2
	Transformers, Analog Devices, Signal Conditioning, Digital Electronics (logic gate, combinational circuit), Data Acquisition systems.	3
3	Modeling, Analysis and Control of Physical Systems: Basics of System Modeling: LTI and LTV systems, Need for modeling, Types of modeling, Steps in modeling, Building blocks of models, Modeling of Electro-mechanical systems, Mechanical Systems ,System Transfer Functions, Stability Analysis using Root Locus Method, Stability Analysis using Bode Plots, PID Controllers(with and without Time Delay)	5
4	Sensors and Actuators: Static characteristics of sensors and actuators, Position, Displacement and Proximity Sensors, Force and torque sensors, Pressure sensors, Flow sensors, Temperature sensors, Acceleration sensors, Level sensors, Light sensors, Smart material sensors, Micro and Nano sensors, Selection criteria for sensors, Actuators: Electrical Actuators (Solenoids, Relays, Diodes, Thyristors, Triacs, BJT, FET, DC motor, Servo motor, BLDC motor, AC motor, Stepper	7

	motors), Hydraulic and Pneumatic actuators, Design of Hydraulic and Pneumatic circuits	
5	Microprocessors: Introduction features, 8085 IC pin configuration and architecture, its applications. Microcontrollers: Introduction, features and application 8051 Assembly language programming steps, Synchronous and Asynchronous sequential system	3
6	Programmable Logic Controllers (PLCs): Architecture, Number Systems, Basics of PLC. Programming, Logics, Timers and Counters, Application on real time industrial automation systems.	4
	Case Studies:Design of pick and place robot, Car engine management system, Automated manufacturing system, Automatic camera, Automatic parking system, Safety devices and systems.	3
	TOTAL	28

TEXT BOOKS

1. Devadas Shetty, Richard A.Kolkm, "Mechatronics system design, PWS publishing company, 2009.
2. Bolton, "Mechatronics – Electronic control systems in mechanical and electrical engineering, 2nd edition, Addison Wesley Longman Ltd., 2009.

REFERENCE BOOKS

1. Brian morriss, "Automated manufacturing Systems – Actuators Controls, sensors and Robotics", McGraw Hill International Edition, 2000.
2. Bradley, D. Dawson, N.C.Burd and A.J. Loader, "Mechatronics: Electronics in product and process", Chapman and Hall, London, 1999.

5ME5-15: Computer Integrated Manufacturing systems

Credit: 2 Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To Impart knowledge to students in recent advances in the Computer Integrated Manufacturing Engineering to educate them to prosper in Manufacturing engineering and research related professions.
2. To inculcate ability to relate Computer Integrated Manufacturing engineering issues to broader engineering and social context.
3. To understand the latest advances in the manufacturing perspectives, such as automation, computer aided planning.
4. Understand the importance of computer aided principles in the Product development and manufacturing
5. To provide student with an academic environment aware of excellence, leadership, written ethical codes and guidelines, and the life-long learning needed for a successful professional career.

Course Outcomes

Student will be able to

1. Demonstrate an ability to design a system, component or process as per needs and specifications.
2. Show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues.
3. Apply the fundamental principles of computer aided technologies to the solution of practical problems in industrial automation.
4. Apply the fundamental principles of integral design to the solution of practical problems related to process planning, control and material handling

S. No	Contents	Hours
1	**Introduction:** Production Systems Facilities, Automation in Production Systems, Manual Labor in Production Systems, Automation Principles and Strategies; Manufacturing Operations, Production Concepts and Mathematical Models, Cost of Manufacturing Operations, Role of computer in manufacturing.	5
2	**Group Technology and Cellular Manufacturing:** Parts Classification and Coding, Production Flow Analysis, Cellular Manufacturing. Industrial Robotics: Robot Anatomy and Related Attributes, Robot Control Systems, Robot Applications.	5
3	**Computer Aided Process Planning**: Traditional Process Planning, Retrieval process planning system, Generative Process Planning, Machinability data systems, computer generated time standards.	4
4	**Automation:** definition and broad characteristics of flexible manufacturing cells, systems, flexible transfer lines, place of flexible manufacturing systems in CIM, economics and technological justification for FMS, design and planning, role of associated technologies such as GT, JIT and Simulation, Operation and Evaluation, Scheduling Problems, FMS Hardware, Control Aspects of FMS, Flexible Machining Cells.	8
5	**Computer Aided Production Management Systems:** Introduction to computer aided PPC, Introduction to computer aided inventory management, manufacturing resource planning (MRPII), computer process monitoring and shop floor control, computer process control.	3

6	**Introduction to Material Handling:** Material Transport Systems, Storage Systems, Conventional / Automated Storage Systems, Automatic Identification Methods.	3

TEXT BOOKS

1. M. P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson Education, 4th Ed.
2. Tien-Chien Chang, Richard A. Wysk, Hsu-Pin Wang, Computer Aided manufacturing, Pearson, 3rd Ed.
3. P.N. Rao, CAD/CAM: Principles and Applications, McGraw-Hill Publication, New Delhi, 3rd Ed.

REFERENCE BOOKS

1. Ibrahim Zeid, R Sivasubramanian, CAD/CAM - Theory and Practice, Tata McGraw Hill, New Delhi, 2nd Ed.
2. P. G. Ranky, Computer Integrated Manufacturing: An Introduction with Case Studies, Prentice-Hall, 1985
3. N. Singh, Systems Approach to Computer Integrated Design and Manufacturing, John Wiley & Sons, 1996.

5ME5-16: Entrepreneurship Development

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. Understand Entrepreneurship Fundamentals: Provide students with a solid understanding of the fundamental concepts, theories, and principles of entrepreneurship.
2. Develop Business Planning Skills: Equip students with the skills to develop a comprehensive business plan, including market analysis, financial projections, and strategic marketing.
3. Foster Innovation and Creativity: Encourage students to cultivate innovative thinking, creativity, and problem-solving abilities to develop unique business ideas and solutions.
4. Prepare for Practical Entrepreneurship: Prepare students for real-world entrepreneurship by imparting practical knowledge about legal aspects, funding sources, and scaling up a business.

Course Outcomes

Student will be able to -

1. Learn Business Plan Development: Students will be able to create a well-structured business plan encompassing all essential elements, such as market analysis, financial projections, and growth strategies.
2. Make Entrepreneurial Mindset: Students will demonstrate an entrepreneurial mindset by exhibiting creative thinking, adaptability, and a willingness to take calculated risks.
3. Have Legal and Regulatory Awareness: Students will gain insights into legal structures for businesses, intellectual property rights, and compliance requirements, enabling them to make informed decisions.
4. Have Practical Entrepreneurial Skills: Students will acquire practical skills related to identifying opportunities, raising funds, managing operations, and executing marketing strategies in real-world entrepreneurial ventures.

S. No	Contents	Hours
1	**Introduction to Entrepreneurship** Introduction to Entrepreneurship and its Significance, Characteristics and Qualities of an Entrepreneur, Types of Entrepreneurship and Role in Economy, Entrepreneurial Process and Steps in Starting a Venture	3
2	**Opportunity Identification and Idea Generation** Identifying Business Opportunities and Market Analysis, Idea Generation Techniques and Creativity in Entrepreneurship, Feasibility Study and Business Model Canvas **Market Research and Business Planning** Market Research and Target Audience Identification, Competitive Analysis and Marketing Strategies, Business Plan Development and Components	6
3	**Funding and Financial Management** Sources of Funding: Bootstrapping, Angel Investors, Venture Capital, Financial Management Basics for Entrepreneurs, Budgeting, Financial Projections, and Cash Flow Management **Legal and Regulatory Aspects** Legal Structures for Businesses: Sole Proprietorship, Partnership, Company, Intellectual Property Rights and Trademark Registration, Compliance and Licensing Requirements **Entrepreneurial Marketing**	11

	Digital Marketing and Online Presence for Startups, Social Media Marketing and Building a Brand, Sales Strategies and Customer Relationship Management	
4	**Operations and Human Resource Management** Operations Management and Supply Chain Basics, Human Resource Management for Small Businesses, Team Building, Recruitment, and Employee Motivation **Scaling Up and Exit Strategies** Growth Strategies and Scaling Up a Business, Managing Risks and Challenges in Entrepreneurship, Exit Strategies: Selling a Business or Succession Planning **Innovation and Social Entrepreneurship** Innovation and Technology in Entrepreneurship, Social Entrepreneurship and Sustainable Business Models	8

TEXT BOOKS

1. Kuratko, Donald F. and Hodgetts, Richard M. "Entrepreneurship: Theory, Process, and Practice" South-Western, ISBN 978-0324258264,2003.
2. Khanka ,S.S. "Entrepreneurship Development" S Chand & Company, 2007, ISBN-13 978-8121918015.

REFERENCE BOOKS

1. Ries, Eric "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses" Currency, 2011, ISBN-13 978-0307887894.
2. Hisrich, Robert D., Peters, Michael P., Shepherd, Dean, A. "Entrepreneurship: A South Asian Perspective" McGraw Hill Education, 2018 ,10th edition, ISBN-13 978-9353163457.

5ME5-17: Surface Engineering

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. Select an appropriate surface modification technique depending on the need.
2. Characterize the coatings developed using these techniques.
3. Apply the knowledge to find solution for surface degradation.

Course Outcomes

Student will be able to -

1. Select a conventional surface engineering treatment for a specific application
2. Design a suitable thermal spray technique for surface modification of various materials
3. Deploy laser modification of surfaces to enhance properties
4. Select and use an appropriate deposition technique for various materials
5. Use various characterization tools
6. Design a suitable Nano coating system for various applications

S. No	Contents	Hours
1	**Introduction** Fundamental of surface engineering – Surface dependent properties and failures of engineering components. Surface engineering – Scope, Classification, definition and general principles.	3
2	**Conventional Surface Engineering** Cleaning, pickling, etching, grinding, polishing and diffusion process - carburizing, nitriding - Electroless and Electroplating - Anodization and Electrophoretic deposition.	5
3	**Advanced Surface Engineering Practices** Thermal spray technologies –introduction - APS and HVOF - Effect of process parameters on coating properties - Cold spraying , warm spraying and Solution plasma spraying.	5
4	**Laser surface modification** Laser hardening - Laser cladding - Laser texturing.	4
5	**Thin film technologies** PVD and CVD Technologies - Evaporation –thermal and Electron beam - PVD, RF- DC, EBM, CVD-HFCVD, PECVD and ion implantation.	4
6	**Coating characterization** Thickness and Roughness - Porosity and Adhesion - SEM and AFM - Raman and XPS - XRD – phases and stresses - Scratch and wear testing.	5
7	**Nano-coatings** Importance and applications – Preparation of nano-coatings.	3
	Total	28

TEXT BOOKS

1. Peter Martin, Introduction to Surface Engineering and Functionally Engineered Materials, Interscience Wiley, 2011.

REFERENCE BOOKS

1. Steven Abbott, Nigel MacDermid , Nanocoatings: Principles and Practice: FromResearch to Production, DEStech Publications, 2013.
2. Atul Tiwari, Lloyd Hihara, James Rawlins, Engineered Tribological Composites: The Art of Friction Material Development, 1st edition, Butterworth, 2014.
3. Angela Piegari, François Flory, Optical Thin Films and Coatings, 1st edition, Woodhead Publishing, 2013.

5ME5-18: Lean Manufacturing

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. This course will enable students to understand and analyze modern manufacturing systems to understand the production process and improve production efficiency.
2. The course provides practical knowledge that can be applied to solve industry related problems.
3. This course will enable students to use various tools for lean manufacturing.

Course Outcomes

Student will be able to -

1. CO1: To understand the whole scope of manufacturing systems.
2. CO2: To identify sources of manufacturing problems by analyzing the production line.
3. CO3: To apply various tools for lean manufacturing.

S.No.	Contents	Hrs.
1	Introduction Lean Manufacturing: Evolution of Manufacturing, Competitive Advantage, Basic Concept of Lean Manufacturing. Incremental Improvement: Kaizen, PDCA Cycle, Five Why Process, Value Analysis/ Value Engineering, Process Re-Engineering	7
2	Basic Problem Solving and Improvement Tools: Check Sheet, Histogram, Pareto Analysis, Scatter Diagram, Process Flowchart, Cause-And-Effect Analysis, Run Diagram. Just In Time: Value Added and Waste Elimination: Value Added Focus, Source of Waste, JIT Principles, JIT Limitations, JIT Implementation Barriers	7
3	Elements Of Lean Manufacturing: Small Lot Production - Set Up Time Reduction – Traditional Approaches, SMED Methodology, Techniques for Set-Up Reduction. Preventive Maintenance Program, Total Productive Maintenance	7
4	Pull Production System – Concept, Pull and Push Production Systems Contrasted, Kanban, CONWIP Method Introduction To Group Technology and Cellular Manufacturing	7

TEXT BOOKS

1. John M. Nicholas, Competitive Manufacturing Management: Continuous Improvement, Lean Production, Customer-focused Quality, McgrawHill, 1998
2. Pascal Dennis, Lean Production simplified, CRC Press, 3rd ed.

REFERENCE BOOKS

1. Jeffrey Liker, The Toyota Way, Mcgraw Hill, 2004
2. Masaaki Imai, Gemba Kaizen: A Commonsense Approach to a Continuous Improvement Strategy, McgrawHill, 2018, 2nd ed.

5ME5-19: Introduction to Total Quality Management and reliability

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To learn the basic concepts of quality and quality management from organizational point of view.
2. To understand the basic philosophy of TQM and be aware of various international/national Quality awards.
3. To learn the basic concepts of reliability.

Course Outcomes

Student will be able to -

1. CO1: To understand the TQM approach for manufacturing/service organization.
2. CO2: To understand management aspect of quality.
3. CO3: To apply basic concepts of reliability.

S.No.	Contents	Hrs.
1	The meaning of Quality, Evolution of Quality, Basic Concepts of Quality: quality improvement, dimensions of quality, quality control, Quality of design and quality of conformance, Quality policy and objectives, Quality Planning, Quality Costs and Cost of Failure.	8
2	Quality and Competitiveness in Business, Zero Defects and Continuous Improvement, Role of Leadership and Commitment in Quality Deployment, Team Building, Total Employee Empowerment, Juran Trilogy, Crosby's 10 points, and Deming's 14 Points,	7
3	Western And Japanese Approach of TQM, Basic Philosophy and Fundamental Models of TQM, International/National Quality Awards: Malcolm Baldridge Award, Deming Prize, European Award, Rajeev Gandhi Award, CII Exim Award, Jamna Lal Bajaj Award, Golden Peacock Award	5
4	Reliability and Life Testing- Failure models of components, definition of reliability, MTBF, Failure rate, common failure rate curve, types of failure, reliability evaluation in simple cases of exponential failures in series, paralleled and series-parallel device configurations, Redundancy, and improvement factors evaluations. Introduction to Availability and Maintainability.	8

TEXT BOOKS

1. Douglas C. Montgomery, Introduction to Statistical Quality Control, Wiley, 2019, 8th ed.
2. Amitava Mitra, Fundamentals of Quality Control and Improvement, Wiley, 3rd ed.

REFERENCE BOOKS

1. Besterfield, Dale H., Total Quality Management, Pearson Education, 2012, 7th ed.
2. James R. Evans, Total Quality Management, Organization, and Strategy, Thomson, 4th ed.

5ME5-20: Composite Materials

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. Develop a comprehensive understanding of composite materials, their characteristics, classifications, and applications, enabling students to make informed choices for specific engineering applications
2. Acquire knowledge of various manufacturing and fabrication techniques employed in composite production.
3. Attain understanding on mechanical testing methods to determine the mechanical properties of composites and analyze their behavior.

Course Outcomes

Student will be able to -

1. Identify and comprehend the fundamental mechanical behavior of composite materials, enabling the ability to predict the behavior of novel material combinations accurately.
2. Apply appropriate composites in specific applications based on their properties, showcasing an understanding of how composite properties influence material selection.
3. Analyze manufacturing and fabrication techniques for composites, enabling informed recommendations during composite behavior evaluation.
4. Understand testing methodology to determine the mechanical properties, identify defects, and conduct failure analysis of composites.
5. Analyze composites through mechanics approach to evaluate their performance and structural characteristics.

S. No	Contents	Hours
1	**Introduction:** Characteristics and classification of composites, Types of reinforcements, Types of matrices, Types of composites, Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC), Properties of composites in comparison with standard materials, Application of composites. Advantages and disadvantages of composites.	5
2	**Reinforcements Materials:** Metallic, Polymer, Ceramic, Glass and Natural fibers, Whiskers and Short Fiber, Nano-fillers, Reinforcement fibers, Woven fabrics and Nonwoven random mats. **Matrix Materials**: Metal matrix, Polymer matrix, Ceramic matrix, Bio-Based Matrix, Carbon-Carbon composites, Polymer Matrix Nanocomposites, Comparison of matrix materials, Criterions for the selection of constituents.	6
3	**Manufacturing Techniques:** Hand lay-up, Spray-up, Filament winding, Pultrusion, Resin transfer molding (RTM), Reinforced reaction injection molding, Compression molding, Injection molding, Autoclave curing. **Fabrication and Processing**: Cutting, machining, and drilling composites, Joining and bonding techniques, Surface treatments, Additive Manufacturing of Composites, Self-Healing Composites.	6
4	**Mechanical Testing**: Determination of mechanical properties of composites – tensile, compression, flexure, shear testing, Failure Modes of composites, Toughening mechanisms in	5

	composites. Non-Destructive Testing (NDT) for Composites.	
5	**Laminated Composites**: Lamina and Laminate Lay-up, Ply-orientation, Longitudinal strength and stiffness, Transverse strength and stiffness, Mechanics of short fiber composites, Stress-strain relationships of anisotropic lamina with arbitrary orientations, Analysis of laminated composites, Types of laminates, Stress-strain variation in laminates, Thermal and hygrothermal stresses in laminates, Failure criteria, Inter-laminar stresses in composites.	6

TEXT BOOKS

1. K.K. Chawla, Composite materials, Springer, New York, 1998
2. A. K. Kaw, "Mechanics of Composite Materials", CRC Press, 2005.
3. B. D. Agarwal, L. J. Broutmen, and K. Chandrashekhara "Analysis and performance of Fiber Composites", John Wiley and Sons, New York 2015.
4. S.C. Sharma, Composite materials, Narosa Publications, 2000

REFERENCE BOOKS

1. S.T. Peters, "Handbook of Composites", Chapman Hall, 1998
2. F.L. Mathews and R.D. Rawlings, "Composite Materials: Engineering and Science", Woodhead Publishing, 1999.
3. R.M. Christensen, "Mechanics of Composite Materials", Dover Publications, 2005.

5ME4-20: Manufacturing Technology Lab

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

The course provides students with

1. Fundamental knowledge and principles of various machine tools.
2. The basic concepts of computer numerical control (CNC) machine tool, machining methods and CNC programming.
3. Conducting work sampling time study, and method time measurements.
4. Process a given set of data, characterize the process behavior using descriptive statistics (Control charts).
5. Idea about robotic arm movements.

Course Outcomes

Upon successful completion of the course the students will be able to;

1. **CO1:** Work on CNC machine tools will develop understanding of their working principles, machining methods and CNC programming.
2. **CO2:** Analyze the machining data and will be able to control the process.
3. **CO3:** Able to conduct time study.
4. **CO4:** Able to work on Robotic movements and machining centers.

S. No	Contents (Any ten experiments)
1	Study of capstan lathe and its tooling and prepare a tool layout and job as per given drawing.
2	Study of the structure of a CNC turning centre
3	Manual part programming using G and M codes for Turning, Step turning, Taper turning, multiple turning, Facing, Multiple facing, thread cutting and radius turning on cylindrical components.
4	Part-Programming on the above CNC machines and execution of part programs for Machining given profiles (at least 03 different jobs).
5	Study and practical demonstration on Vertical Machining center and Horizontal Machining center
6	Determination of time standard for a given job using stopwatch time-study.
7	To carry out a work sampling study.
8	To conduct process capability study for a machine in the workshop.
9	Variable control charts – Plotting and interpretation of variable control charts for X and R and Process capability determination.
10	Attribute Control charts – Plotting and interpretation of attribute control charts P-Charts and C- Charts
11	Study and practical demonstration on Coordinate measuring machine,
12	To determine 5 Axis Robotic Arm movement and its degree of rotation.
13	To prepare a given job using 3d Printer.

5ME4-21: Theory of Machines Lab- II

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. To perform various practical to assimilate the basic concepts and principles of devices/machines.
2. To perform practical to analyse free/forced vibrational system with different degree of freedom/constraints

Course Outcomes

Student will be able to -

1. CO-1: By performing, observing and comparing with theoretical results, of devices /machines/equipment, able to understand principles, clearly, it provides good concepts about the principles of devices/machines/equipment. And ready to use concepts in real engineering fields.
2. CO-2: By performing, observing and comparing practical results with theoretical values of the vibrational system of different degrees of freedom with different end constraints for free/forced vibration, it provides good concepts of basics of vibrational system and also to select correct methods to analyse the vibration behaviour of the system.

Sr. No.	Contents
1.	To verify the torque relation for gyroscope.
2.	To plot force vs. radius and lift vs. speed curves for governors.
3.	To perform wheel balancing.
4.	To perform static and dynamic balancing on balancing set up.
5.	To verify relation $T = 2\pi\sqrt{(l/g)}$ for a simple pendulum.
6.	To determine radius of gyration of compound pendulum.
7.	To verify the Dunkerley's rule. (whirling of shaft)
8.	Performing the experiment to find out damping co-efficient in case of free vibration.
9.	To determine the radius of gyration of given bar by using bifilar suspension.
10.	To determine natural frequency of a spring mass system.
11.	Harmonic excitation of cantilever beam using electro-dynamic shaker and determination of resonant frequencies.
12.	Study of Vibration measuring instruments.
	Perform study of the following using Virtual Lab http://www.vlab.co.in/
13.	Forced Vibration of a Cantilever Beam with a Lumped Mass at Free End: To calculate the natural frequency and damping ratio for forced vibration of a single DOF cantilever beam system, experimentally; and compare the results with theoretical values.
14.	Harmonically Excited Forced Vibration of a Single DOF System: To analyze the forced vibration response of a single DOF system at diff damping ratio and frequency ratio.
15.	Calculate the natural frequency and damping ratio for forced vibration of a single

5ME4-22: Heat Transfer Lab

Credit: 1 Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objective:

The course should enable the students to:

1. Understand the various forms of heat transfer and their applications in real life problems.
2. Analyze different methods to calculate the heat transfer coefficient in various heat transfer problems.
3. Analyze the theoretical knowledge and apply it in conducting experiments in the forms of heat transfer.

Course Outcomes:

Student will be able to

1. Perform steady state conduction experiments to estimate thermal conductivity of different materials for plane, cylindrical and spherical geometries.
2. Perform the transient heat conduction experiment and obtain variation of temperature along the length of the pin fin.
3. Estimate heat transfer coefficients in forced convection, free convection and determine effectiveness of heat exchangers
4. Perform radiation experiments: determine surface emissivity of a test plane and stefan-Boltzmann's constant and compare with theoretical values
5. Estimate heat transfer coefficients in condensation, boiling and effectiveness of heat pipe

Sr.No.	NAME OF EXPERIMENT (Perform any ten)
1	To Determine Thermal Conductivity of Insulating Powder.
2	To Determine Thermal Conductivity of a Metal Rod.
3	To Determine the Heat Transfer Rate and Temperature Distribution for a Pin Fin.
4	To Determine the Emissivity of the Test Plate Surface.
5	To Determine Stefan Boltzmann Constant of Radiation Heat Transfer.
6	To Determine the Surface Heat Transfer Coefficient for Heated Vertical Cylinder in Natural Convection.
7	To Determine the Heat Transfer Coefficient in Drop Wise and Film Wise condensation.
8	To Evaluate the critical heat flux value by studying different zones of boiling
9	To determine the LMTD and Effectiveness of Concentric Tube type Heat Exchanger in Parallel and Counter Flow Modes.
10	To Determine the convective heat transfer coefficient in forced convection
11	To Determine Thermal Conductivity of a Liquid
12	To Determine the thermal conductivity of a lagged pipe apparatus
13	To Demonstrate the effectiveness of a heat pipe in the cooling of complex systems
14	To Study and Compare LMTD and Effectiveness of Shell &Tube /Helical Coil / Cross Flow Heat Exchangers

Important Note: It is mandatory for every student to undertake a Mini project. Mini project shall be a group activity. A group shall consist of maximum five students. Final evaluation sessional component shall include 30% weight age to mini project.

Heat exchanger design for different applications, designing for thermal insulation, Use of relevant BIS codes for designing.

TEXT BOOKS

1. Holman J. P, Heat Transfer, Tata McGraw Hill, New Delhi, (SIE) 10th Ed.
2. Nag P. K., Heat and Mass Transfer, Tata McGraw Hill, (SIE) 3rd Ed.

REFERENCE BOOKS

1. Cengel Y.A., Heat and Mass transfer, Tata McGraw Hill, (SIE) 5th Ed.
2. Ozisik M. Necati, Heat Transfer - A Basic Approach, McGraw Hill, New York, 1985.
3. Frank P. Incropera and David P. DeWitt, Fundamentals of Heat and Mass Transfer, John Wiley & Sons, New York, 2013, 7th Ed., Wiley Student Editiom.

5ME4-23: Machine Design Practice – I

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. To teach students how to apply the concepts of stress analysis, theories of failure and material science to analyse commonly used machine components.
2. To impart knowledge and enable students to design common mechanical components

Course Outcomes

Student will be able to -

1. CO1: Know the material properties, coding and design consideration for selecting the material.
2. CO2: Demonstrate understanding of various theories for design under static loading, identify the failure criteria and apply appropriate theory of failure for design.
3. CO3 Apply the concept of designing under static load to various machine elements

Students can practice using the data handbook in class, but the data handbook will not be given in the exam, students should memorize the formulas on their own

S.No.	Sessional Work	Hours
	Problems on:	
1.	IS coding of various engineering materials	2
2.	Examples of design considerations in components made by casting, forging and machining	2
3.	Design of spigot and socket cotter joint and simple knuckle joint	4
4.	Design of beams, levers and laminated springs.	4
5.	Design of shafts, keys and couplings	6
6.	Design of threaded fasteners and power screws	2
7.	Design of curved beams	2

6ME4-01: Turbo Machines

Credit: 4Max **Marks: 100(IA: 30, ETE: 70)**

3L+1T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To learn classification of turbomachines
2. To calculate energy transfer through a turbo machine
3. To understand energy transfer and losses in compressors, turbines, pump, fans and blowers

Course Outcomes

Student will be able to

1. Conceptualizing the basic principal of turbomachines, their classification & associated concepts.
2. Analyze the thermodynamics & fluid mechanics aspects of a turbomachine
3. Elaborate & evaluate the concept of velocity formulations and Energy Transfer within a Turbomachine
4. Illustrate the applications of turbomachines as Axial Machines & Radial Machines
5. Analyze the stage performance of turbomachines.

S. No	Contents	Hours
1	**Introduction to Turbo-machines** Introduction to Turbomachines. Classification of Turbomachines; Different types of Turbomachines based on various parameters; Axial, Radial and Mixed Flow Machines, Energy transfer between fluid and rotor, Dimensionless parameters, specific speed, applications, stage velocity triangles, work and efficiency.	5
2	**Axial Flow Compressors** Basic constructional features, Advantages of axial flow compressors, working principle, velocity triangle, elementary theory, stage work, work done factor, stage loading, degree of reaction, Supersonic and transonic stages, Performance characteristics.	5
3	**Centrifugal Compressors** Components and description, velocity diagrams, slip factor, energy transfer, power input factor, stage pressure rise and loading coefficient, pressure coefficient, degree of reaction, Centrifugal compressor characteristic, surging, rotating Stall and Choking	6
4	**Axial Flow Turbines** Introduction, Stage velocity triangle, Single impulse stage, Multistage velocity compounded impulse and Multistage pressure compounded impulse, Reaction stages, Blade to gas speed ratio, Losses and efficiencies, Performance charts, Low hub-tip ration stage.	6
5	**Radial Flow Turbines** Elements of radial turbine stage, Stage velocity triangles, H-S diagram, Stage losses, Outward flow radial stage and Performance characteristics.	5
6	**Axial Flow Pumps** Description, velocity triangles, work done on the fluid, energy transfer, axial pump characteristics, cavitation.	5

7	**Centrifugal Pumps** Main parts, work done and velocity triangles, slip and slip factor, pump losses and efficiencies, minimum starting speed, net positive suction head, performance curve.	5
8	**Fans and Blowers** Fan and Blowers types-stage and design parameters-flow analysis in impeller blades-volute and diffusers, losses, characteristic curves and selection, drives and noise. Noise problems in fans and Blowers	6

TEXT BOOKS

1. S.M. Yahya, “Turbine, Fans and Compressors”, Tata McGraw-Hill, 2002.
2. A Valan Arasu, “TurboMachines”, Vikas Publishing House Pvt. Ltd., 2009
3. Subramanya, K., “Hydraulic Machine”, Tata McGraw-Hill, 2013
4. Jagdish Lal, “Hydraulic Machinery”, Metropolitan Books Co, 2007

REFERENCE BOOKS

1. Turton R.K., “Principle of Turbo Machinery”, Springer Publication, 1994
2. William W., “Fundamentals of Turbo Machinery”, John Wiley and Sons, 2008.
3. Shepherd Dennis G., Principles of Turbo Machinery, Mac Millan Publisher, 1956

6ME4-02: Control System & Advanced Measurement Theory

Credit: 4Max **Marks: 100(IA: 30, ETE: 70)**

3L+1T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To develop skills, to analyze feedback control systems in continuous- and discrete time domains and learn methods for improving system response transient and steady state behavior (response).
2. To Understand system stability concept and learn methods for examining system stability in both time and frequency domains including determining the system stability margins.
3. To introduce techniques and instrumentation used in mechanical measurement and Metrology
4. To develop understanding of basic measuring devices including transducers, and pressure, flow rate, and temperature measurement devices

Course Outcomes

Student will be able to -

1. Analyze feedback control systems in continuous- and discrete time domains and learn methods for improving system response transient and steady state behavior (response).
2. Understand system stability concept and learn methods for examining system stability in both time and frequency domains including determining the system stability margins.
3. Have comprehensive knowledge about techniques and instrumentation used in mechanical measurement and Metrology
4. Develop understanding of basic measuring devices including transducers, and pressure, flow rate, and temperature measurement devices

S. No	Contents	Hours
1.	Scope and Introduction	1
2.	Feedback systems, mathematical modelling of physical systems; Laplace transforms, block diagrams, signal flow graphs, state-space models;	4
3.	Time domain analysis: performance specifications, steady state error, transient response of first and second order systems;	5
4.	Stability analysis: Routh-Hurwitz stability criterion, relative stability;	4
5	proportional integral, PI, PD, and PID controllers; Lead, lag, and lag-lead compensators; Root-locus method: analysis, design; Frequency response method: Bode diagrams, Nyquist stability criterion, performance specifications, design;	5
6.	Statespace methods: analysis, design; Physical realizations of controllers: hydraulic, pneumatic, and electronic controllers.	5
7.	Basic concepts of measurement, functional elements of instruments, classification of measuring instruments, methods of correction for interfering and modifying inputs, Good measurement practices	4
8.	Transducers, classification of transducers and their applications, piezoelectric transducers	4

9.	Strain gauges, pressure measurement, flow measurement, temperature measurement, Force and torque measurement, displacement and acceleration measurement, thermo physical properties measurement, flow visualization, air pollution sampling and measurement	8

TEXT BOOKS

(Control)

1. K. Ogata, Modern Control Engineering, 4th Ed., Pearson Education Asia, 2015.
2. B. C Kuo and F. Golnaraghi, Automatic Control Systems, 8th Ed., John Wiley, 2013.

(Measurement)

1. Instrumentation, Measurement and Analysis- Nakra and Chaudhary
2. T.G. Beckwith, J.H. Lienhard V & R.D. Marangoni, Mechanical Measurements, Pearson, New Delhi, 2013.

REFERENCE BOOKS

(Control)

1. M. Gopal, Control Systems: Principles and Design, 2nd Ed., Tata McGraw-Hill, 2012
2. M Gopal, Modern Control System Theory, 2nd Ed., New Age International, 1993.

(Measurement)

1. E.O. Doeblin & D.N. Manik, Measurement Systems, 6th edition, McGraw Hill India Pvt. Ltd., New Delhi, 2013.3.
2. J.P. Holman, Experimental Methods for Engineers, 7th edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2004

6ME4-03: Machine Design – II

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To teach students how to apply the concepts of stress analysis, theories of failure and material science to analyse commonly used machine components.
2. To impart knowledge and enable students to design common mechanical components

Course Outcomes

Student will be able to -

1. CO1: Analyse and design mechanical components subjected to fluctuating loads.
2. CO2: Design helical springs and flat belts and understand the selection of flat and V-belt from manufacturer's catalogue.
3. CO3 Design various gears such as spur, bevel, helical and worm for given power and velocity ratio.
4. CO4: Design sliding contact bearing and select a suitable rolling contact bearing from the manufacturer's
5. CO5: Design internal combustion engine components such as piston, cylinder, connecting rod and crank shaft.

Examination Note: Students can practice using the data handbook in class, and data handbook will be given in the exam.

S.No.	Contents	Hours
1.	**Fatigue Considerations in Design:** Variable load, loading pattern, endurance limit, Influence of size, surface finish, notch sensitivity and stress concentration, Goodman line, Soderberg line, Design of machine members subjected to combined, steady and alternating stresses, Design for finite life, Design of shafts under variable Stresses.	8
2.	**Design for Springs:** Design of helical compression, tension, torsional springs, springs under variable stresses. **Design of power transmitting belts:** Design of flat belts, effect of centrifugal tension and initial tension on transmission of power, selection of flat and V-belts from manufacturer's catalogue	8
3.	**Design of gear teeth:** Lewis and Buckingham equations, wear and dynamic load considerations, design of spur, helical, bevel and worm gears	8
4.	**Design of sliding bearings:** Methods of lubrication, hydrodynamic, hydrostatic, boundary lubrication, design of hydrodynamic bearings for minimum friction and maximum power transmission, thermal equilibrium of hydrodynamic bearings. **Rolling contact bearings:** Selection of rolling element bearings for different loads and load cycles from manufacturer's catalogue.	8
5.	**Design of IC Engine components:** Piston, cylinder, connecting rod and crank shaft.	8

TEXT BOOKS

1. V. B. Bhandari, Design of Machine Elements, McGraw Hill, 5th edition, 2020.
2. R.C. Bahl and V. K. Goel, Mechanical Machine Design, Standard Publishers Distributors, 2010 edition
3. P. C. Sharma and D. K. Aggarwal, Machine Design, S. K. Kataria and Sons (New Delhi), 13th ed., 2017.

REFERENCE BOOKS

1. Richard G. Budynas, J. Keith Nisbett, et al.: Shigley's Mechanical Engineering Design, McGraw Hill Education (India), 11th edition, 2020.
2. U. C. Jindal: Machine Design, Pearson Education India, 1st edition 2010

6ME4-04: Refrigeration and Air conditioning

Credit: 3 Max **Marks: 100 (IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objective:

1. To present a platform oriented in-depth knowledge of Refrigeration and Air Conditioning.

Course Outcomes:

Student will be able to

1. Explain the principles and applications of various natural and artificial refrigeration systems.
2. Describe the concepts of psychrometric properties & processes and their applications in air-conditioning.
3. Explain and analyze different refrigeration cycles & systems and their application in HVAC.
4. Perform the heating/cooling load calculations and effects of HVAC system on environment.

S. No	Contents	Hours
1	**Introduction and Vapour Compression Refrigeration System:** Objective, scope and the outcomes of the course, Refrigeration and second law of Thermodynamics, Refrigeration effect and unit of Refrigeration, Heat pump, reversed Carnot cycle Vapour Compression Refrigeration System: analysis of simple vapour compression refrigeration cycle by p-h and T-S diagrams, effect of operating conditions Multiple Evaporator and Compressor System: applications, individual compressor, compound compression, multiple evaporators, cascade system	8
2	**Gas Cycle Refrigeration:** Limitations of Carnot cycle with gas, reversed Brayton cycle, Brayton cycle with regenerative heat exchanger Air refrigeration cycle for air craft: Necessity of cooling of air craft, basic cycle, boot strap, regenerative and reduced ambient cycle: analysis, merits and demerits, DART	5
3	**Refrigerants, Equipments and Other Refrigeration Systems (description only):** Refrigerants: Classification, Nomenclature, selection of refrigerants, global warming potential of CFC refrigerants Refrigeration Equipments: Compressor, condenser, evaporator, expansion devices, their types & working Vapour absorption refrigeration system, Electrolux refrigerator, Lithium Bromide - Water system, Water vapour refrigeration system, Vortex tube refrigeration system, thermo electric refrigeration system	9
4	**Psychrometry and Human Comfort:** Classification of Air-Conditioning Systems, ASHRAE Nomenclature, Applications of Air-Conditioning, Psychrometry - Air-water vapor mixtures, Psychrometric Properties, Psychrometric Chart Psychrometric or Air-Conditioning processes. Human Comfort: Mechanism of body heat losses, factors affecting human comfort, effective	9

	temperature, comfort chart	
5	**Cooling Load Estimation and Selection of Air conditioning Apparatus:** Internal heat gain, system heat gain, RSHF, ERSHF, GSHF, cooling load estimation, heating load estimation, psychrometric calculation for cooling, Selection of air conditioning apparatus for cooling and dehumidification, air conditioning system, year round air conditioning	9
	Total	40

TEXT BOOKS

1. Arora C.P., Refrigeration and Air Conditioning, Tata McGraw Hill, 3rd Ed.
2. Arora S.C. and Domkundwar S., A Course in Refrigeration and Air Conditioning, Dhanpat Rai & Co., 8th Ed.
3. Ballaney P.L., Refrigeration and Air Conditioning, Khanna Publishers, 16th Ed.

REFERENCE BOOKS

1. Stoecker W.F., "Refrigeration & Air Conditioning" McGraw Hill Publication. 2nd Ed. (Indian)
2. Althouse Andrew D., "Modern Refrigeration & Air Conditioning" GoodHeart-Willcox Co., 2002, 18th Ed.
3. Jorden & Priester, Refrigeration & Air Conditioning, Prentice Hall of India, 2003.

6ME5-11: Non Destructive Testing

Credit: 2 Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To acquire familiarity with different types of NDT techniques
2. To understand the basic principles underlying each NDT technique
3. To know the advantages and limitations of each technique
4. To understand the considerations for selection of appropriate NDT technique(s) for various applications
5. To become familiar with common types of defects arising in different types of manufactured products and the NDT method(s) best suited to evaluate them

Course Outcomes

Student will be able to

1. Develop NDT techniques for various products.
2. Acquire skills needed for selection of appropriate NDT technique(s) for new inspection jobs
3. Acquire sound knowledge of established NDE techniques and basic familiarity of emerging NDE techniques.
4. Make use of standards and codes in the area of NDET

S. No	Contents	Hours
1	**Acoustical Methods:** Ultrasonic testing- Generation of ultrasonic waves, Horizontal and shear waves, Near field and far field acoustic wave description, Ultrasonic probes- Straight beam, direct contact type, Angle beam, Transmission/reflection type, and delay line transducers, acoustic coupling and media	5
2	**Ultrasonic Tests:** Transmission and pulse echo methods, A-scan, B-scan, C-scan, F- scan and P-scan modes, Flaw sizing in ultrasonic inspection: AVG, Amplitude, Transmission, TOFD, Satellite pulse, Multi-modal transducer, zonal method using focused beam. Flow location methods, Signal processing in Ultrasonic NDT; Mimics, spurious echo's and noise. Ultrasonic flaw evaluation.	5
3	**Electro Magnetic Methods:** Magnetic particle inspection, introduction to electrical impedance, principles of eddy current testing, flaw detection using eddy current **Radiographic Methods:** Introduction to x-ray radiography, the radiographic process, X-ray and Gamma ray sources, Geometric principles, Factors governing exposure, radio graphic screens, scattered radiation, arithmetic of exposure, radiographic image quality and detail visibility, industrial X-ray films.	6
4	**X-Ray Radiography Processes:** Fundamentals of processing techniques, process control, the processing room, special processing techniques, paper radiography, sensitometric characteristics of X-ray films, film graininess signal to noise ratio in radiographs. The photographic latent image, radiation protection.	6
5	**Optical Methods:** holography- Principles and practices of Optical holography, acoustical, microwave, x-ray and electron beam holography techniques. **Applications:** NDT in flaw analysis of Pressure vessels, piping NDT in Castings, Welded constructions, etc., Case studies.	6

TEXT BOOKS

1. J. Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition, 2011.
2. B. Raj, T. Jayakumar and M. Thavasimuthu, Practical Non Destructive Testing, Alpha Science International Limited, 3rd edition, 2002
3. T. Rangachari, J. Prasad and B.N.S. Murthy, Treatise on non-destructive testing and evaluation, Navbharath Enterprises, Vol.3, 1983.

REFERENCE BOOKS

1. C. Hellier, Handbook of Non-Destructive Evaluation, McGraw-Hill Professional, 1st edition, 2001.
2. J. Thomas Schmidt, K. Skeie and P. Maclntire, ASNT Non Destructive Testing Handbook: Magnetic Particle Testing, American Society for Nondestructive Testing, American Society for Metals, 2nd edition, 1989.
3. V. S. Cecco, G. V. Drunen and F. L. Sharp, Eddy current Manual: Test method, Vol.1, Chalk River Nuclear Laboratories, 1983.
4. B.P.C. Rao, Practical Eddy Current Testing, Alpha Science International Limited, 2006.
5. N. A. Tracy, P. O. Moore, Non-Destructive Testing Handbook: Liquid Penetrant Testing, Vol. 2, American Society for Nondestructive Testing, 3rd edition, 1999.

6ME5-12: Power Generation

Credit: 2 Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To equip students about the working of various power generation units and steam cycles.
2. To educate the students to understand the steam generators, combustion and firing methods in order to make the fullest use of thermal power potentialities.
3. Enable the students to understand in detail about nuclear, gas turbine, hydro and diesel power plants which play an important role in power generation.

Course Outcomes

Student will be able to

1. Analyse different kinds of steam generators and their subsystems
2. Explain different combustion mechanisms, coal, ash and flue gas handling systems
3. Explain the functioning of various types of Nuclear power plants
4. Select the suitable conventional power plant by taking into account all the technical constraints
5. Evaluate the economic aspects of power plant installation and operation

S. No	Contents	Hours
1	Steam Power Plant: Site selection, Components and Layout of steam power plant, vapor power cycles. Steam Generators – Classification and Types of Boilers - Fire tube and Water tube boilers - High pressure and Supercritical boilers - Positive circulation boilers - Fluidized bed boiler - Waste heat recovery boiler, Heat Exchangers - Feed water heaters - Super heaters - Reheaters -Economiser - Condenser- Cooling tower.	5
2	Combustion and Firing Methods: Coal handling and preparation -Combustion equipment and firing methods - Mechanical stokers - Pulverized coal firing systems - Cyclone furnace - Ash handling systems - Electrostatic precipator - Fabric filter and Bag house -Forced draft and Induced draft fans.	5
3	Nuclear Power Plants: Site selection, Components and Layout Principles of nuclear energy - Energy from nuclear reactions - Energy from fission and fuel Burnup - Decay rates and Half - Lives. Boiling water reactor - Pressurized water reactor Pressurized Heavy Water Reactor - Gas cooled reactor - High temperature gas cooled reactor - Fast breeder reactor - Liquid metal fast breeder reactor-reactor materials - Radiation shielding.	5
4	Gas Turbine Power Plants: Site selection, Components and Layout, Open and closed cycles - Intercooling - Reheating and Regenerating - Combined cycle power plant types.	5
5	Hydro Electric Power Plants: Site selection, Components and Layout, Classification of Hydro - electric power plants and their	7

	applications - Selection of prime movers - Governing of turbine. Diesel Engine Power Plant: Site selection, Components and Layout, Subsystems - Starting and stopping - Heat balance - Lubricating and Cooling startegies - Constraints in operating range.	
6	Economics of Power Plants: Cost of electric Energy - Fixed and operating costs - Energy rates - Types tariffs Economics of load sharing - Load Curves.	2

TEXT BOOKS

1. P. K. Nag, Power Plant Engineering: Steam and Nuclear, Tata McGraw-Hill Publishing Company Ltd., Fourth Edition. New Delhi, 2014.

REFERENCE BOOKS

1. R.K.Hegde, Power Plant Engineering Pearson India Education services Pvt. Limited Noida, India, 2015.
2. R. K. Rajput, A Text Book of Power Plant Engineering, Laxmi Publications (P) Ltd. New Delhi, 2015.

6ME5-13: Robotics and Automation

Credit: 2 Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To provide understanding of principles of automation,
2. To provide knowledge of automated flow lines and their types
3. To provide knowledge on concepts of Robotics, kinematics of robot.
4. To provide knowledge on principles of robot drives and controls
5. To provide understanding of sensors used in robots and programming methods.

Course Outcomes

Student will be able to;

1. Understand about automation, their types, components and strategies of automation.
2. Find suitable automation for the given problem in industries according to product development.
3. Understand about the industrial robots, their constructional features and kinematics.
   Do robot programming
4. Appreciate the applications of robotics and be able to apply economic measures to justify advantages of robots in industry.

S. No	Contents	Hours
1	**Introduction to Automation:** Need, type, basic elements of automated systems, manufacturing industries, types of production, functions in manufacturing, organization and information processing in manufacturing, automation strategies and levels of automation. Hardware components for automation and process control, mechanical feeders, hoppers, orienters.	6
2	**Automated flow lines:** Part transfer methods and mechanisms, types of flow lnes, flow lines with and without buffer storage. Quantitative analysis of flow lines. **Assembly line balancing:** Assembly process and system assembly line, line balancinmethods, ways of improving line balance, flexible assembly lines	5
3	**Industrial Robotics:** classification of robot configuration, functional line diagram, degree of freedom, components common types of arms, joints grippers, factors to be considered in the design of grippers. Robot Actuators: actuators, pneumatic, hydraulic actuators, electric & steeper motors, comparison, Position sensors, potentiometers, resolvers, encoders, velocity sensors, tactile sensors, proximity sensors.	5
4	**Manipulator Kinematics:** Robot Kinematics, Direct and inverse kinematics, Robot trajectories, trajectory planning and avoidance of obstacles path planning, joint integrated motion, Control of robot manipulators **Robot dynamics:** Differential transformations, Jacobians, Lagarange, Eulers and Newton – Eulers formations, Methods for orientation and location of objects.	5
5	**Methods of Robot Programming**: Characteristics of task level languages lead through programming methods, software packages, Motion interpolation.	5

	Robot applications in Material transfer, handling, loading and unloading, welding, painting, assembly and inspection.	

TEXT BOOKS

1. R K Mittal and I J Nagrath, Robotics and Control, Tata McGraw Hill, 2004.
2. Saha S.K., Introduction to Robotics, Tata Mc Graw-Hill, 2nd Ed.
3. S R Deb, Robotics Technology and Flexible Automation, Tata Mc Graw-Hill, 1994.

REFERENCE BOOKS

1. Mikell P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education, 2007
2. James A. Rehg, Henry W. Kraebber, Computer Integrated Manufacturing, Pearson Education. 2007
3. Donald Hearn and M.Pauline Baker "Computer Graphics" with OpenGL Prentice Hall, International, 2010

6ME5-14: Principles of Management

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. Familiarity with Management Concepts: Provide students with an understanding of fundamental management concepts, functions, and roles.
2. Effective Decision Making: Develop students' skills in planning, decision making, and problem-solving within a managerial context.
3. Leadership and Team Management: Equip students with knowledge of leadership styles, motivation theories, and effective team management.
4. Ethical and Social Responsibility: Foster an awareness of ethical considerations, corporate social responsibility, and sustainable practices in management.

Course Outcomes

Student will be able to -

1. Learn Management Skills: Students will demonstrate proficiency in managerial functions, including planning, organizing, leading, and controlling.
2. Have idea about Effective Communication: Students will exhibit effective communication skills for leadership, motivation, and conflict resolution.
3. For Ethical Decision Making: Students will apply ethical principles to managerial decisions, considering their impact on stakeholders.
4. Have idea about Adaptability and Innovation: Students will be prepared to manage change, promote innovation, and lead diverse teams in evolving business landscapes.

S. No	Contents	Hours
1	Introduction to Management Introduction to Management and Its Evolution, Functions of Management: Planning, Organizing, Leading, Controlling, Managerial Roles and Skills, Management Challenges in the Modern Business Environment	3
2	Planning and Decision Making Importance of Planning and Types of Plans, Strategic, Tactical, and Operational Planning, Decision Making: Process, Models, and Factors, Organizing and Staffing Organizational Structure and Design, Departmentation and Delegation of Authority, Staffing: Recruitment, Selection, and Training	6
3	Leadership and Motivation Leadership Theories and Styles, Motivation Theories and Employee Engagement, Communication in Management Controlling and Performance Management Controlling Process and Techniques, Performance Management and Measurement, Quality Management and Total Quality Management	6
4	Team Dynamics and Conflict Resolution Team Dynamics, Group Formation, and Team Roles, Conflict Types and Resolution Strategies,	6

	Time and Stress Management Managerial Ethics and Corporate Social Responsibility Managerial Ethics and Ethical Decision Making, Corporate Social Responsibility and Sustainability, Business Ethics and Its Impact on Organizations	
5	Change Management and Innovation Managing Change: Types, Resistance, and Strategies, Innovation and Entrepreneurship in Management, Managing Diversity and Inclusion International Management and Future Trends International Management: Globalization and Cross-Cultural Challenges, Emerging Trends in Management	6

TEXT BOOKS

1. Tripathi, P.C. and Reddy, P.N "Principles of Management" McGraw Hill Education, 4th edition, 2008, ISBN-13 978-0070220881,
2. Prasad, L.M "Principles and Practice of Management" S. Chand, 2021, ISBN-13 978-9351611813.

REFERENCE BOOKS

1. Hannagan ,Tim "Management: Concepts and Practices" Financial Times Prentice Hall,2007, ISBN-13 978-0273711186.
2. Dubrin, Andrew J "Essentials of Management"Cengage Learning, 9th edition,2011, ISBN-13 978-1111765934
3. Robbins, Stephen P. and Coulter, Mary, Fernandez, Agna "Management", Pearson Education, 14th edition, 2019, ISBN-13 978-9353067229.

6ME5-15: Alternate Fuels

Credit: 2 Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. The course provides students with fundamental knowledge regarding the need and availability of alternative fuels
2. In this course, the student comprehends the characteristics of various alternative fuels and their technological viability for usage in IC engines.

Course Outcomes

At the end of the course the student shall be able to

1. Interpret the suitable alternative fuels like CNG and LNG.
2. Explain the characteristics of alcohols in SI & CI engines.
3. Analyze the various gaseous alternative fuels for IC engine applications.
4. Determine various properties of bio fuels and their significance in IC engines.
5. Explain the concepts of Electrical vehicle, Fuel cell and solar cars.

S. No.	Contents	Hours
1	**Need for alternate fuel:** Availability and properties of alternate fuels, general use of alcohol, LPG, hydrogen, ammonia, CNG and LNG, vegetable oils and biogas, merits and demerits of various alternate fuels, introduction to alternative energy sources. Like EV, hybrid, fuel cell and solar cars.	5
2	**Alcohols:** Properties as engine fuel, alcohol and gasoline blends, performance in SI engine, methanol and gasoline blends, combustion characteristics in CI engines, emission characteristics, DME, DEE properties performance analysis, performance in SI & CI Engines.	5
3	**Natural Gas, LPG, Hydrogen and Biogas:** Availability of CNG, properties, modification required to use in engines, performance and emission characteristics of CNG using LPG in SI & CI engines, performance and emission of LPG. Hydrogen; storage and handling, performance and safety aspects.	6
4	**Technical Background of Diesel/Biodiesel fuels:** Oil feed stocks, Transesterification, Biodiesel production from Vegetable oils and waste cooking oil, High blend levels of biodiesel, Testing, Biodiesel Oxidation stability, Performance in Engines, Properties of bio-fuels and their importance in the context of IC Engines. Vegetable Oils: Various vegetable oils for engines, esterification, performance in engines, performance and emission characteristics, biodiesel and its characteristics.	6
5	**Electric, Hybrid, Fuel Cell and Solar Cars:** Layout of an electric vehicle, advantages and limitations, specifications, system components, electronic control system, high energy and power density batteries, hybrid vehicle, fuel cell vehicles, solar powered vehicles.	6
	Total	**28**

TEXT BOOKS

1. S.S. Thipse, Alternate Fuels, Jaico Publishing house, India, 2010
2. Alternate Fuels Guide Book, L. Richard, P.E. Bechhold, Society of Automotive Engineers, 1997

REFERENCE BOOKS

1. G.R. Nagpal and S.C. Sharma, Power Plant Engineering, 16th Edition, Khanna Publishers, 1995.
2. Bent Sorensen, Hydrogen and Fuel Cells: Emerging Technologies and Applications, Elsevier Academic Press, UK
3. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003
4. Automotive Emission Control, Crouse and Anglin, McGraw Hill
5. Alternative Fuels Guidebook, Bechtold R.

6ME5-16: Operations Management

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. Familiarity with Management Concepts: Provide students with an understanding of fundamental management concepts, functions, and roles.
2. Effective Decision Making: Develop students' skills in planning, decision making, and problem-solving within a managerial context.
3. Leadership and Team Management: Equip students with knowledge of leadership styles, motivation theories, and effective team management.
4. Ethical and Social Responsibility: Foster an awareness of ethical considerations, corporate social responsibility, and sustainable practices in management.

Course Outcomes

Student will be able to -

1. Learn Management Skills: Students will demonstrate proficiency in managerial functions, including planning, organizing, leading, and controlling.
2. Have idea about Effective Communication: Students will exhibit effective communication skills for leadership, motivation, and conflict resolution.
3. For Ethical Decision Making: Students will apply ethical principles to managerial decisions, considering their impact on stakeholders.
4. Have idea about Adaptability and Innovation: Students will be prepared to manage change, promote innovation, and lead diverse teams in evolving business landscapes.

S. No	Contents	Hours
1	Introduction to Operations Management Introduction to Operations Management and its Importance, Operations Strategy and Competitive Advantage, Role of Operations in Business Success, Operations Management Trends and Challenges	2
2	Designing Processes and Quality Management Process Selection and Design, Process Mapping and Analysis, Total Quality Management and Continuous Improvement Forecasting and Capacity Planning Demand Forecasting Techniques, Capacity Planning and Utilization, Resource Allocation and Balancing Workloads	6
3	Inventory Management Inventory Control Models and Techniques, Economic Order Quantity (EOQ) and Just-In-Time (JIT) Systems, ABC Analysis and Inventory Cost Management Production Planning and Scheduling Master Production Scheduling and Material Requirements Planning, Shop Floor Control and Scheduling Techniques, Lean Production and Kanban Systems	8
4	Supply Chain Management Supply Chain Design and Network Optimization, Supplier Relationship Management and Logistics,	4

	Sustainability and Green Supply Chain Management	
5	Quality Control and Six Sigma Statistical Process Control and Quality Control Tools, Six Sigma Methodology and DMAIC Process, Case Studies in Quality Improvement	4
6	Project Management Project Planning, Scheduling, and Resource Allocation, Project Management Techniques and Critical Path Method, Risk Management in Projects Operations Improvement and Future Trends Business Process Reengineering and Operations Improvement , Emerging Trends in Operations Management	4

TEXT BOOKS

1. Stevenson W J, Operations Management, Tata McGraw Hill, 13th Ed.
2. Kumar, S. Anil and Suresh, N. "Operations Management" New Age International Pvt Ltd Publishers,2nd edition,2012, ISBN-13: 978-8122421774

REFERENCE BOOKS

1. Slack, Nigel , Chambers, Stuart and Johnston, Robert "Operations Management" Financial Times/ Prentice Hall,2006, ISBN-13:978-0273708476.
2. Heizer, Jay and Render, Barry "Principles of Operations Management" Pearson Education, 12th edition, ISBN-13:978-9332586703.
3. Krajewski, Lee J. , Malhotra ,Manoj K., and Ritzman, Larry P. "Operations Management: Strategy and Analysis" Pearson,13th edition, 2021, ISBN-13:9780136860631
4. Paneerselvam, R. "Production and Operations Management" Prentice Hall India Learning Private Limited, 3rd edition, 2012, ISBN-13: 978-8120345553

6ME4-20: Machine Design Practice – II

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. To teach students how to apply the concepts of stress analysis, theories of failure and material science to analyse commonly used machine components.
2. To impart knowledge and enable students to design common mechanical components

Course Outcomes

Student will be able to -

1. CO1: Know the phenomenon of fatigue and design the components subjected to fluctuating loads.
2. CO2: Design various gears for the given power and velocity ratios.
3. CO3: Design helical springs, power transmitting belts and select a proper belt from the manufacturer's catalogue
4. CO4: Design sliding contact bearings and select a suitable rolling element bearing from the manufacturer's catalogue
5. CO5: Design various IC Engine components

Students can practice using the data handbook in class, and data handbook will be given in the exam.

S.No.	Sessional Work	Hours
	Problems on:	
1.	Design for fluctuating loads	4
2.	Design of spur, bevel, helical and worm gears	6
3.	Design of helical springs, belts, selection of flat and V-belt	4
4.	Design of sliding contact bearings and selection of rolling element bearings	6
5.	Design of IC engine components such as cylinder, piston, connecting rod and crank shaft	4

6ME4-21: Turbo Machine Lab

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. Develop the ability to operate, control, and evaluate the performance of turbomachinery setups while adhering to safety guidelines.
2. Acquire practical skills in conducting experiments, collecting data, and interpreting performance parameters of turbomachines.

Course Outcomes

Upon successful completion of the course the students will be able to;

1. **CO1:** Understand the underlying principles and concepts of various types of turbomachines, comprehending their working mechanisms and basic operational characteristics.
2. **CO2:** Proficiently operate turbomachinery setups, showcasing the ability to safely start, stop, and control machines while adhering to operating guidelines.
3. **CO3:** Analyze and interpret essential performance parameters of turbomachines, including flow rates, pressure ratios, and efficiency, applying principles of fluid dynamics and thermodynamics.
4. **CO4:** Plan, set up, and conduct experimental tests on turbomachinery, accurately collecting data, and employing basic data analysis techniques to evaluate machine performance.
5. **CO5:** Demonstrate a strong understanding of safety protocols in turbomachinery environments and prepare reports summarizing experimental procedures, observations, and conclusions.

S. No	Contents
1	Study and calibration of flow measuring instruments and devices
2	To Find the Overall Efficiency of Centrifugal Pump Test Rig
3	Cavitation Test Rig
4	Performance test on a centrifugal fan.
5	Performance test on an axial compressor
6	To Determine the Coefficient of Impact of Jet
7	To Conduct a Test on Pelton Wheel Turbine at Constant Head
8	To Conduct a Test on Francis Turbine Test Rig
9	Performance Test on Gear (Oil) Pump Test Rig
10	To determine Efficiency of Kaplan Turbine Test Rig

6ME4-22: Thermal Engineering Lab

Credit: 1 Max **Marks: 100 (IA: 60, ETE: 40)**

0L+0T+2P

Course Objective:

1. The course provides students with fundamental knowledge and principles of various thermal machines/devices.
2. In this course, the students apply the fundamentals and principles of various thermal machines/devices to practical applications.

Course Outcomes:

Student will be able to

1. Understand the principle of working of various machines (petrol/diesel engine and its various systems, viz., fuel supply system, lubricating system, cooling system and ignition system, exhaust gas analyser, mechanical heat pump, refrigeration and air conditioning system, simple steam turbine, hydraulic turbines and hydraulic pumps).
2. Students will be able to perform experiments on various machines (engines, exhaust gas analyser, mechanical heat pump, refrigeration and air conditioning system, Simple Steam Turbine, hydraulic turbines and hydraulic pumps), record the readings and subsequently evaluate the results and compare the same with the theoretical values.
3. Students will be able to analyse and find deviations, if any, duly substantiated with reasons/theory.

S.No	Name of Experiment Any 12 experiments may be conducted out of 16
1	Study of working of two & four stroke petrol engine and diesel engine with the help of cut section models
2	Study of various types of boilers and boiler mountings and accessories.
3	Study of fuel supply system of a petrol engine (simple carburetor) and Diesel engine (fuel pump and fuel injector)
4	Study of Ignition systems of an IC Engine (Battery and Magneto ignition system) and Electronic ignition system.
5	Study of Lubrication system of an IC Engine (mist, splash and pressure lubrication)
6	Study of cooling systems of an IC Engine (air cooling and water cooling)
7	To perform constant speed load test on a single cylinder diesel engine and to plot performance curves and prepare the heat balance sheet
8	To estimate the Indicated Power, Friction Power and Mechanical Efficiency of a multi-cylinder Petrol Engine. (Morse Test)
9	Analysis of engine exhaust gases using Orsat apparatus / gas analyzer.
10	To study refrigeration cycle, determination of coefficient of performance of cycle and tonnage capacity of refrigeration unit.
11	To determine the COP and tonnage capacity of a Mechanical heat pump

12	To study various controls used in Refrigeration and Air conditioning system.
13	Determination of dryness fraction of steam.

TEXT BOOKS:

1. Ganeshan, V., Internal Combustion Engine, Tata Mc Graw Hill, 4th Ed.
2. Arora C.P., Refrigeration and Air Conditioning, Tata McGraw Hill, 3rd Ed.

6ME4-23: Automation Lab

Credit: 1 Max **Marks: 100 (IA: 60, ETE: 40)**

0L+0T+2P

Course Objective:

1. The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:
2. Maintain Industrial Automation systems.

Course Outcomes:

Student will be able to

1. Identify different components of an automation system.
2. Interface the given I/O device with appropriate PLE-module.
3. Prepare a PLC ladder program for the given application.
4. Select the suitable motor drives for the specified application.
5. Prepare a simple SCADA application.

S.No	Name of Experiment (Perform any 12)
1.	Identify various automation systems available in different appliances/devices/machines in day-to-day use.
2.	Identify various parts and front panel status indicators of the given PLC.
3.	Use PLC to test the START STOP logic for two inputs and one output system.
4.	Develop/Execute a ladder program for the given application using following:- timer, counter, comparison, logical, arithmetic instructions.
5.	Use PLC to control the following devices: lamp, motor, push button switches, proximity sensor
6.	Measure temperature of the given liquid using RTD or Thermocouple and PLC.
7.	Develop/test ladder program to blink LED/lamp.
8.	Develop and test the Ladder program for sequential control application of lamps/ DC motors.
9.	Develop and test ladder program for traffic light control system.
10.	Develop and test ladder program for pulse counting using limit switch /Proximity sensor.
11.	Develop /test ladder program for automated car parking system.
12.	Develop/test ladder program for automated elevator control.
13.	Develop / test ladder program for rotating stepper motor in forward and reverse direction at constant speed.
14.	Develop/test ladder program for tank water level control.

15.	Develop / test ladder program to control speed of stepper motor with suitable drivers.
16.	a. Identify various front panel controls of Variable Frequency Drive (VFD) (smart drive). b. Control speed of AC/DC motor using VFD
17.	Use various functions of SCADA simulation editors to develop simple project.
18.	Develop a SCADA mimic diagram for Tank level control.
19.	Develop SCADA mimic diagram for Flow control of the given system.
20.	Simulate Tank level control using available SCADA system